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Agricultural Memorandum No. 309

Machinery Work Days in the Autumn and Winter Periods (East Anglia)

Introduction

Earlier Memorandum (Nos. 168, 182, 211) were concerned with the time likely to be available for field work in the Spring, when soil structure was a primary consideration.

Similar attempts to relate field observations of work or no work to weather data over the autumn period, and in particular an attempt to relate weather and days on which root harvesting will be tackled, have come to nothing. The reason would appear to be that farmers are prepared to put machinery on to the land under almost any conditions, with the expectation that winter frosts will restore a friable structure by the time that the season for seed bed preparation comes around again.

Nevertheless, a particular year still occasionally catches the farmer out, and there is a continuing interest in the number of reasonable working days that may be expected over a typical sample of seasons.

If only a moderate correlation can be established between rainfall amounts and observations of work/no work, then indirect methods have to be employed to arrive at the planning data needed by farm management.

Procedures

(1) It is perhaps as wel to report first an unsuccessful attempt at data manipulation.

The criteria developed for machinery work days in the Spring involved the sequence of daily rainfall amounts. In the autumn and winter, the farmers decisions on days of work or no work implied no agreement on the rainfall amounts that were limiting to field work; there could be no simple carry over of the spring criteria for work days into the autumn period. Consideration was now given to monthly rainfall and the frequency distribution of days of given rainfall amounts.

For a given station (Cambridge), long period accummulated frequencies of daily rainfall, for each month, were plotted on logarithmic paper (and gave an approximate straight line in each case). For the spring months, for which an average number of work days (5 years in 10) is known from earlier work, it was now possible to identify the average daily rainfall that permitted work. The cumulative frequency curve of this limiting rainfall amount was now calculated for the spring months of the individual years of the sample. Curves parallel to the accumulative frequency of work day curves of the earlier memoranda were obtained, albeit with some displacement. For example, this procedure gave a excess of four days per month over the known number of work days for medium soil.

An attempt was made to transfer this procedure to the autumn and winter months. We are not working completely 'in vacuo' since farm management already have an estimate of the Gang Work Days available on the average soil in the average year.

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Use was made of those Gang Work Days to identify daily rainfall amounts that were limiting to work. Cumulative frequency of work day curves from the data of the months of individual years were now drawn. These were not parallel to the known curves for the spring. It was apparent that one simple translation would not bring the spring and autumn curves into coincidence at all probability levels. An arbitrary adjustment was required at each probability level to produce a fit to the known distribution of work days in the Spring in a typical sample of years. There was no basis on which to make the correct choice.

(2) Table 1 draws on Ag. Mem. 145 and 146 and sets down average monthly rainfall and potential transpiration for a typical station in Central East Anglia.

Ag. Mem. 250 sets out dates of return to soil moisture capacity and places a limit to a maximum actual deficit of 5 inches. Approximate soil moisture deficits for our sample situation, month by month, are also shown in table 1.

It would appear from Ag. Mem. 250 that at most stations in East Anglia, field capacity is reached in 75% of years in December or early January, and in almost every year by early February. The machinery work days achieved in February are basically undertaken with the soil close to field capacity. This criteria enables us to extend the probable work days of February back into the winter and autumn months.

We are primarily interested in the lower half of the cumulative frequency curve and the number of work days likely to be available in the worse than average year.

If one were to summarise the table of Ag. Mem. 250 which shows the time of return to field capacity in the east of England we might deduce the information shown in table 2.

If we concentrate on the work days available on the medium soil, then earlier memoranda (and the Gang Work Day data) both suggest a total of not more than 13 Machinery Work Days available in the average February (50% of years). Since in 50% of years, field capacity is reached in or before early December, it is reasonable to take the number of such work days likely to be available in January and December as approximately those available in February (ie under the same soil moisture conditions).

Some adjustment is required for the different number of calendar days in each month and the differing monthly average rainfall totals, together with the differing monthly probabilities of dry days. If in the light of the earlier memoranda we take a dry day in February, on medium soil, as one with daily rainfall $\leq .14$ inches, then we may obtain the relative frequency of days which meet such a criteria in any other month from data contained in Hydrological Memorandum No. 19 - Table V (Accumulated Frequencies of Daily Rainfall).

We make the assumption that the ratio of 'dry days' in the different months, together with the ratio of the number of calendar days in the different months should be taken, simultaneously, as multiplying factors to the number of work days in February to arrive at the number of Machinery Work Days in January and December.

This enables us to begin to build up the following table.

Table 3
Medium Soil - Machinery Work Days

	February	January	December	November	October
50% of years	13	15	15	16	18

Table 1 suggests that in the average March we are operating with a soil moisture deficit of around 2 inches, similar to that in May. However, the drying rate of the soil (when a crop cover is present) is at least an order of magnitude greater in March than in November. So we may place an upper limit to the number of Machinery Work Days in November as 22 days, the number available in the average March (50% of years) on medium soil. A lower limit is set by the number of such work days in December ie. 15 days. In setting the number of Machinery Work Days in November at some where between 15 and 22 days, if due weight is given to the rate at which the surface is likely to dry (and on which trafficability depends), then the suggestion is that we should not put the number of work days at no more than 16 days.

A similar arguments appealing the months of October and June (for the latter month, the number of Gang Work Days is set at 25 days) suggests we might place the number of Machinery Work Days in the average October, on medium soil, at not more than 18 days.

We may now complete table 3.

An estimate of the number of Machinery Work Days at probability levels other than 50% is now required.

The assumption that a return to field capacity in the autumn is one of the determining factors in traffic cability would seem reasonable. This enables us to suggest that a simple translation in time of the data shown in table 3 might provide an acceptable estimate of work days around this time of return. Taking the reference points afforded by table 2 enables us to suggest that in 25% of years we might expect not more than $\frac{(13 + 15)}{2}$ = 14 work days in November and 15 such days in October; in 10% of years we might expect perhaps no more than 13 work days in October on a medium soil.

We have established no relationship between time of return to field capacity and work days in the subsequent spring. Nor should we necessarily expect any such relationship. This means we have to return to the earlier memoranda to establish the appropriate number of work days at various probability levels in February on a medium soil. We place the number of Machinery Work Days in 25% of years on medium soil at not more than 12 days; and in 10% of years at not more than 10 days.

We may now interpolate between the months of February and October to achieve an estimate of the work days in the intervening months at the 25% and 10% probability levels.

On the assumption that the relative advantage found for light, medium and heavy soils for field work in the spring may be carried over into the autumn and and winter periods, we may now draw up the following table 4.

Table 4

Estimates of maximum number of Machinery Work Days - East Anglia

	Soil Type								
	Heavy			Medium			Light		
	Percentage of years			Percentage of years			Percentage of years		
	50%	25%	10%	50%	25%	10%	50%	25%	10%
October	14	11	9	18	15	13	21	18	16
November	12	10	7	16	14	(11)	19	17	14
December	11	9	6	15	(13)	(10)	18	16	13
January	9	8	6	13	(12)	(10)	16	15	13
February	9	8	6	13	12	10	16	15	13

( ) interpolated values

Current estimates of the Gang Work Days available in the East of England are now given for comparison.

October	19 days
November	16
December	14
January	14
February	13

Meteorological Office
Cambridge
January 1970.

Table 1

Data for a typical East Anglian Station

Month	Average		
	Rainfall	Potential Transpiration	Soil Moisture Deficit
January	1.45 indes	0.05 indes	-
February	1.38	0.40	-
March	1.30	1.30	-
April	1.77	2.26	0.5 indes
May	1.80	3.38	2.1
June	1.47	3.76	4.4
July	2.42	3.73	5.0
August	1.90	3.10	5.0
September	2.04	1.93	4.9
October	1.96	0.85	3.8
November	2.08	0.15	1.9
December	1.65	0.00	.25
January	1.95	0.05	-
February	1.38	0.40	-

Table 2

Time of return to field capacity - East of England

In 10% of years in or before	In 25% of years in or before	In 50% of years in or before
Late September/ early October	Mid November	Early December